Module III

10. a) Let \( h \) be a homomorphism \( h(a) = 01, h(b) = 0. \)
   
   i) Find \( h^i(L_1) \), where \( L_1 = (10+1)^* \)
   
   ii) Find \( h(L_2) \), where \( L_2 = (a+b)^* \)
   
   iii) Find \( h^i(L_3) \), where \( L_3 \) is the set of all strings of 0's and 1's with an equal number of 0's and 1's.

b) Find the Greibach normal form grammar equivalent to the following CFG:
   
   \[ S \rightarrow AA \mid 0 \]
   
   \[ A \rightarrow SS \mid 1 \]

11. a) Show that the following languages are not context free:
   
   i) \( \{a^i b^j c^k \mid i, j \geq k \} \)
   
   ii) \( \{a^i b^j c^k \mid i < j < k \} \)

b) Give a CFG for the language \( N(M) \) where \( M = (\{q_0, q_1\}, \{0, 1\}, \{Z_0, X\}, \delta, q_0, Z_0, \phi) \)
   
   and \( \delta \) is given by \( \delta(q_0, 1, Z_0) = \{(q_0, XZ_0)\}, \delta(q_0, \epsilon, Z_0) = \{(q_0, \epsilon)\}, \delta(q_0, 1, X) = \{(q_0, XX)\}, \delta(q_1, 1, X) = \{(q_1, \epsilon)\}, \delta(q_0, 0, X) = \{(q_1, X)\}, \delta(q_1, 0, Z_0) = \{(q_0, Z_0)\} \)

Module IV

12. a) Write notes on the following:
   
   i) recursive and recursively enumerable languages
   
   ii) Church's hypothesis
   
   iii) decidable and undecidable problems
   
   iv) Turing machine with multiple tracks

b) Design the Turing machine to recognize the following language:
   
   \( \{0^n 1^n 0^n \mid n \geq 1\} \)

13. a) Design a Turing machine to implement multiplication function.

b) Explain the variants of Turing machines.

\( (4 \times 20 = 80 \text{ marks}) \)